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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
BULLETIN 18

CONTRIBUTIONS TO THE PALÆONTOLOGY AND STRATIGRAPHY OF THE JURASSIC SYSTEM IN CANADA

BY
Hans Frebold

OTTAWA
EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
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PREFACE

Little systematic investigation of the widespread Jurassic system of western Canada has been undertaken by the Geological Survey for many years. Hitherto, the best known sections have been those of Skidegate Inlet in the Queen Charlotte Islands (G.S. Bulletin No. 12), but more recently the discovery of fossiliferous Jurassic sections in various widely disposed parts of western British Columbia and Yukon Territory has drawn increasing attention to the stratigraphic significance of Jurassic formations in the geological history of western Canada, and to the desirability of further, more detailed, stratigraphic and palæontological studies.

In the present bulletin, the author has initiated a series of contributions on the Jurassic system, based in this instance on a study of ammonites from collections previously made in the Tyaughton Lake and Whitesail Lake areas of British Columbia and from upper Red Deer River in Alberta. He concludes that the Tyaughton Lake species show a close relationship to synchronous forms of Europe, and that they permit a fairly fine subdivision of the Lower Jurassic series. The ammonites collected in the Whitesail Lake area indicated the occurrence there of Lower Bajocian (lowest Middle Jurassic) beds, a stage hitherto unknown in Canada. Examination of the single ammonite from the Fernie shale, Red River collection, revealed that it had been improperly identified as an Upper Jurassic instead of a late Lower Jurassic (Toarcian) species.

GEORGE HANSON,
Chief Geologist, Geological Survey of Canada

OTTAWA, October 10, 1950

Figure 1. Index map showing location of Tyaughton Lake and Whitesail Lake map-areas, British Columbia, and Red Deer River, Alberta.

AMMONITE FAUNA AND STRATIGRAPHY OF THE LOWER LIAS IN TYAUGHTON LAKE MAP-AREA, BRITISH COLUMBIA

INTRODUCTION

The fossils described in this report were obtained from the Lower Jurassic series of Tyaughton Lake map-area, British Columbia, on the eastern flank of the Coast Mountains (Figure 1). This region was investigated by C. E. Cairnes in 1937 and by C. H. Crickmay in 1939. The general geology is described by Cairnes[1], who states that the Lower Jurassic rocks are partly in faulted contact with the Tyaughton group, which is mainly, if not entirely, of Upper Triassic age. In places, however, the Lower Jurassic (Lias) strata appear to overlie the Tyaughton group conformably. They consist mainly of dark argillite, with limy concretions locally, and shale, in part calcareous. Thin bands of limestone, sandstone, and small-pebble conglomerate are also noted.

The fossil collections comprise especially ammonites that are derived from various stratigraphic zones of the Lower Lias. At one locality fossils of Upper Lias age were also found. Some field determinations of ammonites are published in Cairnes' report, and the following genera were recorded: *Arniotites*, *Asteroceras*, *Echioceras*, *Schlotheimia*, and *Metophioceras*. A more thorough study of this fauna has indicated that the forms tentatively determined as *Arniotites* and *Echioceras* belong to other genera, and in addition to these the genus *Psiloceras* is represented. Most of these ammonites are new for Canada and, therefore, interesting palæontologically as well as stratigraphically, for they record the presence of Lower Lias zones hitherto unknown in Canada. Many of the ammonite specimens are well preserved.

Figure 1 shows the position of Tyaughton Lake map-area in British Columbia. Within this area the fossil localities referred to in the text are indicated on the sketch map, Figure 2. The photographs, Plates XVI to XVIII, taken in 1937 by C. E. Cairnes, illustrate the general topographical conditions in this area.

PALÆONTOLOGY

THE AMMONITE FAUNA OF THE *Psiloceras* BEDS

The fauna described in the first part of this report consists mostly of *Psiloceras*, and, apparently, represents the oldest zone recorded by the fossil collections.

The *Psiloceras* fauna has been collected at the following localities in Tyaughton Lake area:

Loc. 1404 (Cat. No. 10093), Tyaughton Creek, ¾ mile above Spruce Lake Creek; collected in 1939 by C. H. Crickmay. This collection consists of *Psiloceras*. No other ammonites were found.

[1] Cairnes, C. E.: Geology and Mineral Deposits of Tyaughton Lake Map-area, B.C.; Geol. Surv., Canada, Paper 43-15, 1943.

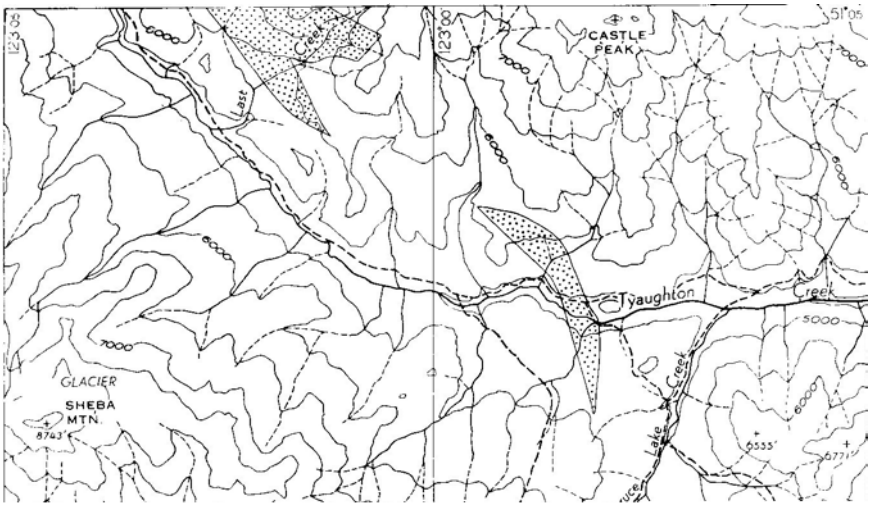

Figure 2. Northwestern part of Tyaughton Lake map-area, British Columbia.

these form straight, clearly defined single ribs, still about 27 to a whorl, on the flanks (*See* Plate II, figures 1a, 1b, and Plate III, figure 1). At this stage the venter is smooth.

The suture line, as already mentioned, is very simple. E[1] is always outside the median line of the venter, is shorter than L1, which is much longer than L2. Two umbilical lobes are observable on the flank. The broadest element of the suture line is the ES; in the specimen illustrated in Plate II, figure 1c, it occupies nearly the whole ventral region. The incisions of none of the lobes and saddles are deep.

In the specimen illustrated in Plate I, figure 4a, the body chamber has a length of more than three-quarters of the last whorl.

Probably all these forms collected in Tyaughton Lake map-area belong to the same species, and this species shows no remarkable variety. As mentioned before, the Canadian form is similar in shape to some types of *Wachneroceras*, but is easily distinguishable from these by its very different suture line.

Among the species belonging to the genus *Psiloceras* are some forms similar to the Canadian species. The specimen of *Psiloceras plicatulum* Quenstedt figured and described by Pompeckj (1893)[2] shows a similar sculpture and whorl section, but the ribs are better defined on the venter than in the Canadian form. The latter also has a narrower umbilicus. The suture line of *P. plicatulum*, as figured by Pompeckj (op. cit., p. 62, fig. 13), is similar in general character, but differs mainly in having a narrower ES. Another comparable form is *Psiloceras reissi* Tilmann from the Lower Lias of Peru[3], a form that like the Canadian species is more involute than *P. plicatulum*. The type of the ribs seems to be similar to that of the Tyaughton area species, but the state of preservation of this unique specimen from Peru does not allow further comparison or identification. *Psiloceras erugatus* Bean from the Lower Lias member of the Laberge series of Yukon, described by E. J. Lees (1934)[4], is a nearly smooth *Psiloceras* and very easily distinguishable from the new Canadian form. Apparently, therefore, the Tyaughton Creek form does not belong to any known species of *Psiloceras*.

Arietites sp. indet.

Plate III, figure 2

On Spruce Lake Creek (Loc. 2106), fragments of an *Arietites* were found with *Psiloceras canadense* sp. nov. in the same pieces of rock. So far as can be judged from their poorly preserved state, these fragments belong to an evolute and widely umbilicate form. The cross-section of the whorls is, apparently, nearly quadrate, with rounded umbilical and ventro-lateral shoulders. On the venter is a keel bordered on each side by a broad, not very deep furrow. The ribs are almost straight on the flanks, but bend forward on the ventro-lateral shoulder. No suture line is observable.

[1] In this publication the following abbreviations for the elements of the suture line are used: E, external lobe; ES, external saddle; Jc, deep incision in the external saddle; L1, first lateral lobe; L2, second lateral lobe.

[2] Pompeckj, T. F.: Beiträge zu einer Revision der Ammoniten des schwäbischen Jura; Lieferg. 1, pp. 62-63, Pl. 5, figs. 1, 1a; Stuttgart, 1893.

[3] Tilmann, H.: Die Fauna des mittleren und unteren Lias in Nord und Mittel-Peru; Neues Jahrb. Min. Beil. Bd. 41, 1917.

[4] Lees, E. J.: Geology of the Laberge Area, Yukon; Trans. Roy. Can. Inst., vol. XX, 1934

The fragment here illustrated in Plate III, figure 2, has some affinities with the genus *Arnioceras* Hyatt[1], the type of which is *Arnioceras ceras* Ag. Hyatt (*A. ceratitoides* Quenstedt)[2], but because of the very poor and incomplete state of preservation no detailed comparison can be made.

Another very poorly preserved and not determinable *Arietites* fragment was found at locality 1429 (Cat. No. 10098).

Some Canadian forms referred to *Arniotites* and *Arnioceras* and derived from the Lower Lias rocks of Parson Bay, British Columbia[3], from the Lias member of the Fernie formation[4], and from the Laberge series of Yukon[5], where *Arnioceras* was reported in association with *Psiloceras erugatus* Bean, are too poorly preserved to compare with the *Arietites* from the Tyaughton Lake area.

It is of interest to note that this questionable *Arietites*, in association with *Psiloceras canadense* sp. nov., has only been found at two localities in the Tyaughton Lake area.

Schlotheimia sp. indet.

Plate III, figure 3

From Spruce Lake Creek (Loc. 2106), a fragment and an imprint of part of another ammonite have been found in the same kind of rock as that from which *Arietites* sp. indet. was obtained.

The fragment is from a comparatively involute form, with a high rectangular whorl section. The venter is nearly flat, the flanks somewhat rounded, and the ribs are undivided except in one place where two of them are connected just above the umbilical edge. The ribs are strongest in the transition zone from the venter to the flanks, but they do not cross the venter.

No doubt this imperfectly preserved form belongs to *Schlotheimia*, but its poor state of preservation does not allow determination of the species. The general shape, however, is similar to that of young specimens of *Schlotheimia charmassei* d'Orbigny, but the ribs of the Canadian form are almost all undivided whereas *S. charmassei* has bifurcate ribs. Another similar form is *Schlotheimia marmorea* Oppel; some young forms of this species have been described and figured by Wähner[6], and show a similar general shape and undivided, or rarely divided, ribs on their inner whorls.

The Canadian form is rare in the beds with *Psiloceras canadense* sp. nov. In addition to the fragment here described from Spruce Lake Creek (Loc. 2106), only one other very questionable specimen was found, on Last Creek (Loc. 1349).

Other Fossils from the Psiloceras Beds

From the localities on Tyaughton and Last Creeks (Loc. 1404 and 1349), only ammonites have been collected, whereas many pelecypods and

[1] Hyatt, A.: Genesis of Arietitidae; Smith. Contr. to Knowledge, Washington Smithsonian Inst., 1889.

[2] Quenstedt, F. A.: Die Ammoniten des schwäbischen Jura, I; Pl. XIII, fig. 10 *(excl. al.)*, 1883-1885.

[3] Crickmay, C. H.: The Stratigraphy of Parson Bay, British Columbia; Univ. of Cal. Publ. in Geol. Sciences, vol. 18, 1929-1930.

[4] Warren, P. S.: A Lower Jurassic Fauna from Fernie, British Columbia; Trans. Roy. Soc., Canada, vol. XXV, sec. IV, 1931.

[5] Lees, E. J.: op. cit.

[6] Wähner, F.: Beiträge zur Kenntnis der tieferen Zonen des unteren Lias in den nordöstlichen Alpen. Beitr. Pal. Österreich-Ungarns; Bd. IV, 1886, pp. 180-185, Pl. 22, figs. 1-6.

some gastropods are found on Spruce Lake Creek (Loc. 2106) together with the ammonites. This accompanying fauna apparently contains no guide fossils.

THE AMMONITE FAUNA OF THE SCHLOTHEIMIA BEDS

Besides the already described *Schlotheimia* sp. indet. found in association with *Psiloceras*, there are localities where representatives of other *Schlotheimia* (partly belonging to the subgenus *Scamnoceras*) have been collected (by C. H. Crickmay in 1939). These localities are:

Loc. 1350 (Cat. No. 10088), on Last Creek at elevation 6,425 feet. Except for *Schlotheimia (Scamnoceras)* cf. *acuticosta* Buckman, no other ammonites have been collected at this locality.

Loc. 1340 (Cat. No. 10085), on Last Creek at elevation 6,160 feet. *Schlotheimia(?)* sp. indet. No other ammonites have been collected at this locality.

Loc. 1342 (Cat. No. 10086), on Last Creek at elevation 6,200 feet. *Schlotheimia(?)* sp. indet. No other ammonites have been collected at this locality.

Description of Species

Schlotheimia (Scamnoceras) cf. *acuticosta* S. S. Buckman

Plate IV, figure 1

Part of the body chamber of a *Schlotheimia* was found at an elevation of 6,425 feet on Last Creek (Loc. 1350), a northern tributary of Tyaughton Creek.

The cross-section of the whorl is rounded trapezoidal. The straight ribs are undivided; in the transition zone between the flank and the venter they are sharply bent forward, and they cross the venter without interruption at an angle of a little less than 90 degrees.

Because of the undivided ribs and the general shape, the specimen belongs to the subgenus *Scamnoceras* (Lange, 1923)[1] the genotype of which is *Schlotheimia (Scamnoceras) angulata* Schloth. From this species the Tyaughton form differs in the lack of interruption of the ribs on the venter. Otherwise the two forms are similar. However, *Schlotheimia acuticosta* S. S. Buckman, another European species that also belongs to the subgenus *Scamnoceras* and that is very similar to *S. angulata*, agrees fairly well with the Tyaughton form, as *S. acuticosta* also is characterized by the lack of interruption of the ribs on the venter. The *S. acuticosta* figured by Buckman (1925, vol. V, Pl. 551)[2] shows similar ribs, but the angle of the ribs on the venter seems to be more than 90 degrees in Buckman's species, whereas this angle is less than 90 degrees in the Tyaughton form. *S. acuticosta* Buckman may be identical with *S. angulosa* W. Lange (1923, p. 199), and some of Reynès' *S. prometheus* may also belong to the same group. The different angles formed by the ribs on the venter, as mentioned above, are probably only to be considered as variations. At any rate the statement can be made that the Tyaughton form belongs to the group of *S. (Scamnoceras) acuticosta* Buckman, and *S. (Scamnoceras) angulosa* Lange. More material, especially showing the suture line, will enable the exact position of the Tyaughton form to be determined. *S. angulosa* belongs in North-

[1] Lange, Werner: Über die Psilonotenstufe des untersten Lias Nord-Deutschlands; Jahrb. Preuss. Geol. Landesanstalt, Bd. 44, 1923.

[2] Buckman, S. S.: Type Ammonites, vol. V, 1925.

west Europe to the uppermost part of the Hettangian, that is, the zone of *S. stenorhyncha*. This zone lies just above that where *S. angulata* Schloth. is common.

Schlotheimia(?) sp. indet.

Plate IV, figures 2 to 4

At elevations of 6,160 and 6,220 feet on Last Creek, some fragments of ammonites were found in which the ribs are of a very similar type to those of *S. (Scamnoceras)* cf. *acuticosta*. They are straight and undivided, but are less prominent, and are nearly extinguished on the venter, which is almost smooth. In some specimens it is barely possible to see the ribs crossing the venter, on which they form an angle of about 90 degrees. It may be that these forms represent a smoother variety of *S. (Scamnoceras)* cf. *acuticosta*, previously described, but because of the incomplete state of preservation (no suture line is visible) no definite determination can be made.

THE AMMONITE FAUNA OF THE *Arietites* BEDS

Representatives of various genera allied to *Arietites* were found by Crickmay in 1939 at various localities in the Tyaughton Lake area. Some of these localities seem to be those where *Psiloceras* and *Schlotheimia*, respectively, have been collected, but the specimens of *Arietites* come from other horizons. They have nowhere been found in association with the *Psiloceras* and *Schlotheimia* described above. The localities with *Arietites* are:

Loc. 1307 (Cat. No. 10080), ½ mile east of Gate Creek and a little more than 1 mile south of Spruce Lake. *Vermiceras scylla* Reynès.

Loc. 1334 (Cat. No. 10084), on Last Creek at an elevation of 5,900 feet. *Vermiceras latisulcatum* Quenstedt.

Loc. 1352 (Cat. No. 10089), on Last Creek at an elevation of 6,680 feet. *Coroniceras bisulcatum* Bruguière.

Loc. 1435 (Cat. No. 10099), 2½ miles east and about ½ mile north of northwest corner of Tyaughton Lake map-area. *Coroniceras* cf. *bisulcatum* Bruguière.

Loc. 1352 (Cat. No. 10089), on Last Creek at an elevation of 6,680 feet. *Agassiceras* cf. *scipionianum* d'Orbigny.

Loc. 1409 (Cat. No. 10096), 2 miles above Spruce Lake Creek. *Asteroceras* cf. *stellare* Sowerby.

Description of Species

Vermiceras scylla Reynès

Plate V, figures 1 to 7; Plate VI, figures 1, 2

Ammonites scylla Reynès, Monographie des Ammonites, I, Pl. 4, figs. 13-25 (1879).

Ammonites spiratissimus Reynès, Monographie des Ammonites, I, Pl. 15, figs. 22-25 (1879).

Ammonites spiratissimus Quenstedt, Ammoniten des schwäbischen Jura, I (*partim* as Pl. 12, fig. 5; Pl. 13, fig. 6) (1885).

Arietites scylla Wähner, Beiträge zur Kenntnis der tieferen Zonen des unteren Lias in den nordöstl. Alpen, vol. 6, p. 309 (1888).

Arietites scylla Fiege, Biostratigraphie der Arietenschichten, p. 69, Pl. 25, figs. 7, 8; Pl. 3, figs. 1, 2; Pl. 16, fig. 5 (1929).

Specimens of small *Arietites* found east of Gate Creek (Loc. 1307) and south of Spruce Lake, at an elevation of 5,170 feet, all belong to the same species. The largest specimen has a diameter of about 69 mm. The state

of preservation is mostly good in earlier stages of growth, up to a diameter of about 23 mm.

The form is widely umbilicate, very slightly involute, and the whorls increase gradually. In early stages of growth the cross-section of the whorls is wider than high, with slightly rounded flanks (*See* Plate V, figure 4b). In later stages the cross-section is higher and more or less oval. At a diameter of about 10 mm. a keel can be observed, and in later stages of growth the keel is clearly developed. Furrows are lacking or only very weak. In early stages of growth, the numerous ribs are straight, or some may be a little retrocostate. In the transition zone between flanks and venter the ribs nearly disappear; they are divided into some very fine branches that cross the venter, where they are bent forward. In later stages of growth, the ribs are slightly arched. No suture line has been observed.

Because of the general shape (widely umbilicate, slowly increasing whorls, straight ribs without nodules, and no, or only weak, furrows), this form belongs to *Vermiceras* Hyatt, the genotype of which is *V. spiratissimum* Quenstedt. The Canadian form differs from this species in having no, or only very weak, furrows. *Vermiceras scylla* Reynès, however, a species very closely related to *V. spiratissimum* Quenstedt, lacks these furrows; the Canadian form agrees also in other observable characters with this species, and is very close to, or even identical with, it.

Vermiceras scylla Reynès occurs, according to K. Fiege (1929), in a zone just below that with *V. spiratissimum* Quenstedt; in the Tyaughton Lake area no other ammonites have been found in association with it.

As pointed out by Wähner (1888, p. 310), *V. scylla* Reynès has also a certain resemblance to *Echioceras raricostatum*, and this may account for the assumption previously made that *Echioceras* is represented in the Tyaughton Lake area. There are, however, as also stated by Wähner, constant differences between *V. scylla* and *E. raricostatum*, especially in the type of the ribs, that make it possible to distinguish these two species.

Vermiceras latisulcatum Quenstedt

Plate VII, figure 1; Plate VIII, figure 1

Ammonites latisulcatus Quenstedt, Ammoniten, p. 85, Pl. 12, figs. 1-6 (1885).

At elevation 5,900 feet on Last Creek (Loc. 1334), some fragments of a large ammonite have been found, all of which, apparently, belong to the same specimen.

The form is slightly involute, the whorls increase only very slowly, and their cross-section is nearly quadratic in all observable stages of growth. The simple, numerous ribs are slightly arched, and they disappear close to the lateral keels. No tubercles are present. The venter is broad, tricarinated with two deep and broad furrows. The large obtuse central keel is prominent, higher than the lateral keels.

The suture line is asymmetrical in this specimen. One-half of E is lying on the flank (Plate VIII). E is deeper than L1, and L1 is deeper than L2. On one of the flanks L1 has two (*See* Plate VIII), on the other flank three (*See* Plate VII), branches. On that flank to which half of E

is moved over, ES is about of the same size as LS. On the other flank, ES is extremely broad, and is divided by a very deep incision (*See* Plate VII, figure 1a) that has about the same size as L2.

Both the general shape and the type of the ribs place this form in *Vermiceras* Hyatt. Quenstedt's *Ammonites latisulcatus*, which belongs to this genus, is very similar as regards the suture line. Also, Quenstedt described (cf. his *A. latisulcatus diplosella*, Plate 12, figure 6) such deep incisions of ES as have been mentioned above. The Last Creek specimen (Loc. 1334) is larger than all the specimens figured by Quenstedt, but in the writer's opinion there is no reason why this form may not be identified with Quenstedt's species.

Vermiceras latisulcatum Quenstedt, which is closely related to *V. spiratissimum* Quenstedt, occurs in western Europe in the lower part of the Lower Sinemurian, and belongs to an horizon that is a little older than that with *Coroniceras*. It is noticeable that the here described Canadian form is not associated with *Coroniceras*.

Coroniceras bisulcatum Bruguière

Plate VI, figure 3; Plate IX, figure 1; Plate X, figure 1; Plate XI, figure 1; Plate XII, figure 1; Plate XIII, figure 1

Ammonites bisulcata Bruguière (pars), Encyclopéd., Méthod. I (1792).

Ammonites multicostata Sowerby, Min. Conch., vol. V, p. 76, Pl. 454 (1824).

Ammonites multicostata Zieten Verst., Württembergs, p. 35, Pl. 26, fig. 3 (1830).

Ammonites bisulcatus d'Orbigny, Pal. Française, Terrains jurass., Céphalopodes, p. 187, Pl. 43 (1842).

Ammonites bisulcatus Oppel, Juraform., p. 77 (1856).

Ammonites bisulcatus Dumortier, Études paléontol. sur les dépôts jurass. du bassin du Rhone, p. 20, Pl. 3, figs. 1-3 (1867).

Ammonites multicostatus Reynès, l.c., Pl. 24, figs. 10-28 (1879).

Arietites bisulcatus Wright, Monograph on the Lias Ammonites of the Brit. Islands, p. 275, Pl. III, figs. 1-2; Pl. IV, figs. 1-3 (1886).

Coroniceras bisulcatum Hyatt, Genesis of the Arietidae, p. 186 (1889).

Arietites bisulcatus E. W. Schmidt, Die Arieten des unteren Lias bei Harzburg, p. 13, Pl. 1, figs. 4-7; Pl. 2, figs. 1, 2 (1915).

Arietites bucklandi multicostatus Fiege, l.c., p. 78, Pl. IV, fig. 8 (1929).

This species has been collected at an elevation of 6,680 feet on Last Creek (Loc. 1352) and at a point $2\frac{1}{2}$ miles east and about $\frac{1}{2}$ mile north of the northwest corner of Tyaughton Lake map-area (Loc. 1435).

The well-preserved large specimen from Last Creek (*See* Plates IX, X, XI) has a diameter of 263 mm. The umbilicus is 136 mm. wide, and the last whorl is 69 mm. high and 64 mm. broad.

The cross-section of the whorls is nearly quadratic, slightly higher than wide. The venter shows the central keel, which is a little higher than the lateral ones and is bordered by not very deep furrows. The ribs, which are almost straight but more or less retrocostate on the flanks, have a tubercle near the ventral border. From this tubercle the ribs bend sharply forward and disappear at the lateral keels. The number of the ribs varies between 36 and 49 on the $4\frac{1}{4}$ visible whorls of the specimen. On the last whorl there

are 49, and on the inner whorls 41, 38, and 36 respectively. The increase in the number of ribs with the number of whorls is also described by Wright (1886, p. 276). The suture line agrees very well with the figures given by other authors: E is much longer than L1, which has three branches. L2, also with three branches, is as deep as L1 but a little narrower. U is not as deep as L1 and L2, and is apparently divided into two branches.

This specimen agrees very well with the figures of this species given by other authors, as, for example, those by Wright (1886, Pl. III).

The smaller specimen from the same locality (Plate XII) has a diameter of 128 mm., and the umbilicus is 67 mm. wide. There are 45 ribs on the last whorl and 41 on the second last. This specimen, therefore, also shows the increasing number of ribs with the increasing number of whorls, and in other respects agrees very well with the equivalent stage of growth of the large specimen described above.

The fragment illustrated in Plate XIII, figure 1, from the same locality shows generally similar conditions to those at the equivalent stage of growth of the large specimen described above; consequently, there is little doubt that this fragment also belongs to the same species.

The whorl fragment from near the northwest corner of the map-area (Loc. 1435), illustrated on Plate VI, figure 3, is poorly preserved, and it is not certain that it belongs to *C. bisulcatum*, particularly as the tubercles of this specimen are more prominent than is usual in this species.

Coroniceras bisulcatum Brug. is closely related to *C. bucklandi* Sowerby, and Fiege (1929) has, therefore, described *C. bisulcatum* Brug. as a variety of *C. bucklandi* under the name *Arietites bucklandi multicostatus* Sowerby.

Coroniceras bisulcatum belongs in Europe to the zone of *C. bucklandi*, in the lower part of the Sinemurian stage.

Agassiceras cf. *scipionianum* d'Orbigny

Plate XIV, figure 1

Ammonites scipionianus d'Orbigny, Terrains jurassiques, Céphalopodes, p. 207, Pl. 51, figs. 7-8 (1843).

Ammonites scipionianus Quenstedt, Jura, p. 69, Pl. 18, fig. 1 (1858).

Ammonites scipionianus Dumortier, p. 33, Pl. 8, figs. 1-2; Pl. 8, fig. 1 (1867).

Ammonites scipionianus Reynès, Pl. 28, figs. 1-8 (1879).

Ammonites scipionianus Quenstedt, Ammoniten, p. 109, Pl. 14, figs. 1-3 (1885).

Arietites scipionianus Wright, p. 289, Pl. 13, figs. 1-3; Pl. 19, figs. 8-10 (1886).

Agassiceras scipionianum Hyatt, p. 197, Pl. 7, figs. 11-15; Pl. 10, figs. 11-13 (1889).

Arietites scipionianus Fiege, p. 80, Pl. 6, fig. 13; Pl. 16, fig. 23 (1929).

Two whorl fragments of large specimens have been found on Last Creek at an elevation of 6,680 feet (Loc. 1352). The state of preservation is poor, but owing to the very characteristic cross-section of the whorl and the absence of furrows on the venter the two fragments belong to, or are closely related to, *Agassiceras scipionianum* d'Orbigny.

In earlier stages of growth, *A. scipionianum* has ribs terminating in tubercles in the transition zone between the flanks and the venter. These tubercles are missing in the later stages of growth, as is also true of the

two fragments of the Tyaughton Lake area. The specimen, illustrated in Plate XIV, figure 1, agrees in this respect rather well with the large fragment of *A. scipionianum* figured by Quenstedt (1885, Pl. 14, fig. 1).

The keel of the two fragments of the Tyaughton Lake area is sharp and prominent, as is usual in this species. A suture line is not visible, but there is little doubt that the two fragments belong to *A. scipionianum* d'Orbigny.

Asteroceras cf. *stellare* Sowerby

Plate XIII, figure 2

A single poorly preserved specimen from Tyaughton Creek, 2 miles above Spruce Lake Creek (Loc. 1409), belongs to a more involute form. The last whorl embraces about half of the others, and the cross-section of the whorls is higher than wide, almost rectangular. The ribs are only very slightly arched on about two-thirds of the flanks, but in the upper third they bend forward sharply. No tubercles are present, and there are about 30 ribs on the last whorl. The central keel is comparatively high, broad, and rounded; the bordering furrows appear at a later stage of growth than the keel; they are about as broad as the keel, but not deep, and are not very prominent. No suture line is visible.

The general shape of this more involute form, with its comparatively rapidly increasing whorls and the type of the ribs, seems to identify it with *Asteroceras* Hyatt. So far as a comparison is possible, *Asteroceras stellare* Sowerby seems closely related. Another related form is *Asteroceras obtusum* Sowerby, but this form has a more quadratic whorl cross-section. In Germany, *Asteroceras stellare* belongs, according to K. Fiege (1929), to the uppermost part of the Lias Alpha (=upper part of Lower Sinemurian) and the lower part of Lias Beta (=lower part of Upper Sinemurian).

STRATIGRAPHY

The ammonite collections made in Tyaughton Lake map-area can easily be placed in the following subdivisions: (1) beds with *Psiloceras;* (2) beds with *Schlotheimia;* and (3) beds with *Arietites.* The youngest of these beds, the *Arietites* beds, can be divided further into several zones. The stratigraphic position of these beds will now be discussed.

BEDS WITH PSILOCERAS

Most of the ammonites from the *Psiloceras* beds described in this report belong to *Psiloceras*, a genus elsewhere characteristic of the lowermost parts of the Lias (Lower Jurassic), the Hettangian; the occurrence of *Schlotheimia* in association with the *Psiloceras* confirms this determination of age. As *Schlotheimia* is especially characteristic of the upper part of the Hettangian, it is probable that this Tyaughton fauna should be placed there.

It has been stated above that the indeterminate fragments of *Arietites* found in the same rock in association with *Psiloceras canadense* sp. nov. and *Schlotheimia* sp. indet. have some affinities with representatives of *Arnioceras.* An occurrence of *Arnioceras* with *Psiloceras* and *Schlotheimia* would be surprising, as in Europe this genus occurs in the Sinemurian and not in the Upper Hettangian. Better material of this questionable *Arietites* must, consequently, be collected before such a possible peculiar association can be explained. In this connection it is important to note that the

association of *Arietites* with *Psiloceras* and *Schlotheimia* in the same rock was only noted at two of the four *Psiloceras*-bearing localities, and the possibility that the *Psiloceras* and *Schlotheimia* at these two localities were mixed with a younger fauna may not be excluded. At present, at any rate, the Tyaughton *Psiloceras* fauna can hardly be placed in any other stage than the Upper Hettangian.

Whether or not the Lower Hettangian is represented in Canada cannot be decided with certainty at present, as the precise age of the fauna of the lower part of the Laberge series in Yukon, containing cf. *Psiloceras erugatus* Bean[1], is unknown. In any case, this *Psiloceras* fauna is also of Hettangian age, and it and the *Psiloceras* fauna of the Tyaughton Lake area are the oldest Lias faunas hitherto found in Canada.

It is of interest to note that *Psiloceras* beds occur in Nevada. Muller and Ferguson[2] have mentioned several species of *Psiloceras* and *Schlotheimia*, in addition to other forms, from the lower part of the Sunrise formation of Nevada. Detailed descriptions of this fauna have not yet been given, but there is no doubt that this part of the Sunrise formation is of Hettangian age, but whether Lower or Upper Hettangian cannot be decided until the *Psiloceras* forms are determined. Therefore, a detailed comparison with the Tyaughton Lake fauna is not possible at this time.

BEDS WITH SCHLOTHEIMIA

In addition to the *Schlotheimia* sp. indet. found in association with *Psiloceras canadense* in the *Psiloceras* beds, at least some forms in the Tyaughton Lake area belong to the subgenus *Scamnoceras*. These forms indicate the presence of uppermost beds of Hettangian age, and are probably a little younger than the *Psiloceras* beds here described. The fact that at all localities they were collected alone and not in association with other forms, seems to indicate that this horizon forms an independent stage within the Lower Lias of the Tyaughton Lake area, as is also the case in Europe. The 'Schlotheimian stage' of Europe has been subdivided into several zones (cf., for instance, Werner Lange, 1923, op. cit). Such a subdivision is not yet possible in Tyaughton Lake area, as the available material is insufficient. The presence of *Schlotheimia* beds is unknown in other places in Canada. In Nevada, this stage seems to be represented, as Muller and Ferguson have, as previously noted, identified *Schlotheimia* from the lower part of the Sunrise formation.

BEDS WITH ARIETITES

The occurrence of zones of the upper part of the Lower Lias in Canada has been known before. Thus, Crickmay[3] places his *Arniotites* fauna from Parson Bay, Harbledown Island, in Queen Charlotte Sound (Pacific Coast), in the "Agassiceratan", "Microderoceratan", and "Asteroceratan" (Lower Sinemurian), and P. S. Warren[4] believes that his interesting *Arniotites* fauna from the lower part of the Fernie formation at Fernie is of about the same age as Crickmay's fauna. Unfortunately, the state of preservation of these two faunas is not good, and it has not been possible to place them

[1] Lees, E. J.: Geology of the Laberge Area, Yukon; Trans. Roy. Can. Inst. No. 43, vol. XX, 1934.

[2] Muller, Siemon Wm., and Ferguson, Henry G.: Mesozoic Stratigraphy of the Hawthorne and Tonopah Quadrangles, Nevada; Bull. Geol. Soc. Amer., vol. 50, 1939.

[3] Crickmay, C. H.: op. cit., p. 59.

[4] Warren, P. S.: op. cit., p. 111.

with certainty. The ammonites, however, that have been collected by Crickmay in Tyaughton Lake map-area allow a comparatively fine stratigraphic subdivision. They all belong to the Lower Sinemurian (*See* Table, p. 14). The various representatives of *Arietites* found in this area show a sequence of ammonite zones similar to that of Europe. According to the stratigraphic succession of the *Arietites* in Germany, investigated by Fiege[1], and presuming a similar succession of the various members of this group in other regions, the *Arietites* of the Tyaughton Lake area are to be arranged as follows: *Vermiceras scylla* Reynès, to the zone of *Vermiceras scylla; Vermiceras latisulcatum* Quenstedt, to the next younger zone of *Vermiceras spiratissimum; Coroniceras bisulcatum* Bruguière, to the next younger zone of *Coroniceras bucklandi; Agassiceras* cf. *scipionianum* d'Orbigny, to the zone of *A. scipionianum;* and *Asteroceras* cf. *stellare* Sowerby, to the next younger zone of *Asteroceras stellare.* A comparison with Fiege's scheme of the sequence of *Arietites* zones in Germany shows that apparently nearly all the German zones of the *Arietites* beds are represented in Tyaughton Lake map-area. In this connection it is also remarkable that the various *Arietites* species of that area were found alone, and not in association with species of another zone, the only exception being *A.* cf. *scipionianum,* which, apparently, was found at the same horizon as *Coroniceras bisulcatum.*

At least part of this Lower Sinemurian stage is also represented in the Sunrise formation of Nevada, which has also supplied, among other forms, *A. bisulcatus* Bruguière.

CONCLUSIONS

The investigation of the Lower Lias ammonites of Tyaughton Lake map-area has shown the presence of an apparently continuous sequence embracing Upper Hettangian (*Psiloceras* beds and *Schlotheimia* beds) and Lower Sinemurian (*Arietites* beds). Within the latter, nearly all the European ammonite zones seem to be represented. A comparison of the stratigraphic scheme of Europe[2] with other Canadian localities, and with the Sunrise formation of Nevada, is summarized in the following stratigraphic table. This shows that apparently a very similar development of the Lower Lias occurs in Nevada. The uppermost beds of the Nevada sequence, however, namely those with fragments of "*Deroceras*", are not indicated in the Tyaughton Lake area. In this connection it is interesting that Muller and Ferguson[3] state that this uppermost Sunrise fauna may prove to be slightly older.

No younger zones of the Lower Lias nor any of Middle Lias have been found in the Tyaughton Lake area, and the writer is inclined to assume that these stages are not represented. Beds of Upper Lias age, however, occur in this area, as proved by the discovery of guide fossils.

Special attention must be given the fact that the ammonites of the Lower Lias of Tyaughton Lake map-area show a very close relationship to European forms. This fact can be given fuller attention when further collections permit a discussion of its palæozoogeographical significance on a broader basis.

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[1] Fiege, K.: Die Biostratigraphie der Arietenschichten Nordwest-deutschlands und Württembergs; Palæontographica, vol. LXXI, 1929.

[2] As a base for comparison, the writer has adopted the scheme of Fiege (1929). This differs in part from those advanced by other authors, and is perhaps not correct in all details, but shows the succession of the principal groups and species of *Arietites.*

[3] Muller and Ferguson: op. cit.

Stratigraphic Position of the Lower Lias Ammonite Fauna of Tyaughton Lake Map-area, British Columbia, in Comparison with Other Regions

Stages		Europe: Subzones of the Lower Sinemurian (according to Fiege) and main zones of the Hettangian	Tyaughton Lake map-area, British Columbia		Other Canadian localities	Nevada: Sunrise formation. Approximate position of the various ammonites found by Muller and Ferguson in comparison with those of the Tyaughton Lake area
Lower Sinemurian	Lias Alpha 3	*Asteroceras stellare*	*Asteroceras* cf. *stellare*	*Asteroceras* beds	"*Arniotites*" fauna from Parson Bay (Crickmay, 1930) and "*Arniotites*" fauna from the lower part of the Fernie formation (Warren, 1931)	
		Agassiceras scipionianum	*Agassiceras* cf. *scipionianum*			
		Coroniceras gmuendense				*A. bisuleatus* Brug., *A. rotiformis* Sowerby, and others
		Coroniceras bucklandi	*Coroniceras bisulcatum*			
		Vermiceras spiratissimum	*Vermiceras latisulcatum*			
		Vermiceras scylla	*Vermiceras scylla*			
Hettangian	Lias Alpha 2	*Schlotheimia (Scamnoceras) angulata*	*Schlotheimia (Scamnoceras)* cf. *acuticosta*	*Schlotheimia* beds		
		Psiloceras planorbe	*Psiloceras canadense* and *Schlotheimia* sp. indet.	*Psiloceras* beds	*Psiloceras* cf. *erugatus* Bean (Lees, 1934) from the lower part of the Laberge series, Yukon	*Psiloceras, Euphyllites, Waehneroceras, Schlotheimia, Phylloceras*

and its surface ornamentation, are essentially similar, in a general way, to those of the corresponding stage of growth of *P. athleta* as figured by d'Orbigny, under the name *Ammonites athleta*, on Plates 163 and 164 of the 'Atlas' to the first volume of the 'Terrains Jurassiques' " does not agree with the facts. *Peltoceras athleta* has a completely different type of ribs.

Without any doubt this Canadian form belongs to the genus *Porpoceras* Buckman[1], which includes "the strongly ornamented, massive, fibulate Dactyloids". Among the known species of this group, *Porpoceras subarmatum* Young and Bird is a closely related form, and it is possible that the Canadian specimen belongs to this apparently somewhat variable species. For instance, a similar rib type seems to be present in Quenstedt's *Ammonites subarmatus*[2], whereas Monestier's *Coeloceras (Porpoceras) subarmatum*[3] shows a somewhat different development, as the ribs are not connected with one another in a tubercle. They are connected, however, in Monestier's *Coeloceras (Porpoceras)* sp. indet., which is very similar to the Canadian form, only larger.

In the writer's opinion, the Canadian form is not a new species but may belong to *P. subarmatum* Young and Bird or some other related form. This question can probably be decided when more Canadian specimens have been collected.

STRATIGRAPHIC AND ZOOGEOGRAPHICAL REMARKS

The statement that the Whiteaves specimen from Red Deer River does not belong to *Peltoceras* but to *Porpoceras* shows that the questionable part of the Fernie group at this locality is not representative of Upper Callovian, Oxfordian, or a still later Upper Jurassic stage, as has been assumed hitherto, but is of Upper Lias, that is, upper Lower Jurassic age. Similar forms occur in Europe in the zone of *Hildoceras bifrons* (Toarcian-Lias Epsilon).

The existence of Upper Jurassic horizons younger than the Callovian *Corbula munda* fauna in the Canadian Fernie group was hitherto based on two forms, *Cardioceras canadense* Whiteaves from the Fernie district and the form discussed here. With the revision of this latter form the existence of younger Upper Jurassic horizons in the Fernie group is based only on the occurrence of *Cardioceras canadense*.

Whereas the presence of the genus *Peltoceras* in Canada would have been surprising, the occurrence of *Porpoceras* is quite to be expected, as deposits of Upper Liassic age have a wide distribution in western Canada. They are hitherto known from Yukon (Laberge series)[4], from the Jasper area, Alberta (Fernie group)[5], from the Moose Mountain area, Alberta (Fernie group)[6], from the Fernie district, British Columbia (Fernie group)[7], from the Whitesail Lake area, British Columbia (Hazelton

[1] Buckman, S. S.: Yorkshire type Ammonites, vol. I, 1911.

[2] Quenstedt, F. A.: Die Ammoniten des schwäbischen Jura, Pl. III, figs. 3, 9, 11 (1885).

[3] Monestier, J.: Ammonites rares ou peu connues et Ammonites nouvelles du Toarcien moyen de la région Sud-Est de l'Aveyron; Mém. Soc. Géol. de France, Nouv. Sér., Mém. No. 15, Paris, Pl. III, fig. 1 (1931).

[4] Cockfield, W. E., and Bell, A. H.: Whitehorse District, Yukon; Geol. Surv., Canada, Mem. 150, 1926.

[5] Collet, L. W.: Sur la présence du Lias inférieur et du Bajocien dans les couches de Fiddle Creek; Compte rendu des séances de la société de Physique et d'Histoire naturelle de Genève, vol. 48, No. 1, pp. 14-18 (1931).

[6] Beach, H. H.: Moose Mountain and Morley Map-areas, Alberta; Geol. Surv., Canada, Mem. 236, 1943.

[7] Warren, P. S.: Present Status of the Fernie Shale; Alberta; Amer. Jour. Sci., vol. XXVII, 1934.

group)[1], from the Tyaughton Lake area[2], British Columbia, and from Maude Island[3], Queen Charlotte Islands, British Columbia. In this connection it is remarkable that at some of these places the presence of the locally common '*Dactylioceras*' has been mentioned. These still uninvestigated forms belong at least to a group very nearly related to *Porpoceras*, and it may be that the genus itself is represented.

The Canadian Lias ammonites seem in many cases to be very nearly related or identical with European forms. This impression, which is based on a preliminary investigation of the hitherto undescribed material in the collections of the Geological Survey of Canada, is also confirmed by the here described *Porpoceras* cf. *subarmatum*.

[1] Frebold, Hans: Lowermost Middle Jurassic in British Columbia (this bulletin).

[2] Here a single hitherto undescribed *Harpoceras* is found (this bulletin).

[3] McLearn, F. H.: Some Canadian Jurassic Faunas; Roy. Soc., Canada, Trans., sec. 4, vol. 21, 1927.

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LOWERMOST MIDDLE JURASSIC FAUNA IN WHITESAIL LAKE MAP-AREA, BRITISH COLUMBIA

INTRODUCTION

An investigation of some fossils from the Whitesail Lake map-area, British Columbia (*See* Figure 1), collected by S. Duffell of the Geological Survey of Canada in 1947, revealed some ammonites representative of the lowermost part of the Middle Jurassic, which hitherto has been unknown in Canada. Associated with these ammonites are a few pelecypods, gastropods, and brachiopods.

The collections were made in the Hazelton group at three localities on the northwest ridge of Troitsa Peak: (1) Loc. T 112 F, at north end of ridge; (2) Loc. T 114 F, 1 mile south of Loc. T 112 F; and (3) Loc. T 115 F, ½ mile south of Loc. T 114 F.

As one of the two ammonite species, *Tmetoceras regleyi* Dumortier, and some of the other fossils were found at all three localities there seems no doubt that the collections were made from the same stratigraphic zone.

DESCRIPTION OF SPECIES

Tmetoceras regleyi (Thiollière) Dumortier

Plate XV, figures 1 to 4

Ammonites regleyi (Thiollière) Dumortier, Dép. Jur. IV, p. 119, Pl. 31, figs. 8, 9 (1874).
Tmetoceras scissum Buckman (*non* Benecke), Inf. Ool., pp. 273-275, Pl. 48, figs. 1-10 (1892).

All the specimens from the Whitesail Lake area are poorly preserved, mostly as imprints from which rubber casts are made. These show clearly the type of ribs and their interruption on the venter. The suture line is not visible. No specimen shows the presence of the constrictions so characteristic of *Tmetoceras scissum* Benecke[1], which is, apparently, a closely related species. Buckman (1892)[2] identified this species with *T. regleyi* Dumortier in spite of the fact that these constrictions are lacking in his English specimens. He was of the opinion that the constrictions were only present in larger specimens, and that the English (and also the French) forms were too small for them to have been developed. But both Dumortier (1874, p. 119)[3] and Haug (cf. Buckman, 1892, p. 274) are convinced that it is necessary to treat *T. scissum* Benecke and *T. regleyi* Dumortier as separate species, and the fact that Benecke's figure of the type *T. scissum* shows the presence of these constrictions also in a stage of growth reached by the English, French, and Canadian forms justifies, in the writer's opinion, retaining *T. regleyi* Dumortier as a separate species.

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[1] Benecke, E. W.: Über Trias und Jura in den Südalpen. Geogn. Pal. Beiträge, vol. 1, 1866.

[2] Buckman, S. S.: A Monograph of the Ammonites of the "Inferior Oolite Series"; Palaeontogr. Soc., 1892.

[3] Dumortier, Études Paléontologiques sur des Dépôts Jurassiques du Bassin du Rhone, IV. Partie Lias Supérieur, 1874.

Tmetoceras regleyi Dumortier is rather variable, especially as regards the shape of the whorl section. This has already been shown by the description and figures given by Buckman of his English forms, and is illustrated also in the Canadian form. Here, the comparatively well-preserved specimen from Troitsa Peak ridge (Loc. T 114 F) pictured in Plate XV, figure 2, has a nearly circular whorl section as is the case of Buckman's specimen (Pl. 48, figs. 1-3). The Canadian specimen clearly shows the straight and undivided, very prominent ribs. On the ventral side, they are slightly forwarded, where a blunt, obscure tubercle is present. In the middle part of the ventral area the ribs are interrupted by a furrow.

Another specimen found on Troitsa Peak ridge (Loc. T 115 F) has a different whorl section (*See* Plate XV, figure 1b). It is higher than wide, and more nearly resembles the elliptical whorl section of Buckman's specimen (Pl. 48, figs. 8-9) and Dumortier's type of *A. regleyi*.

Plate XV, figure 4b and 4c shows the venter with the interrupted ribs of a small specimen from Troitsa Peak ridge (Loc. T 115 F). This specimen is interesting because of its occurrence in association with '*Polymorphites*' cf. *senescens* Buckman (*See* below) in the same piece of rock.

'*Polymorphites*' cf. *senescens* Buckman

Plate XV, figure 5

Polymorphites senescens Buckman, Inf. Ool., p. 268, Pl. 48, figs. 13-15 (1892).

On Troitsa Peak ridge (Loc. T 115 F) another ammonite was found associated with a small *Tmetoceras regleyi* Dumortier in the same piece of rock. Most of this ammonite is preserved as an imprint, from which a rubber cast has been made. Only the last part of the last whorl is preserved as cast.

The type of the ribs in this specimen is very similar to that of *Tmetoceras regleyi* described above, but is different in that the ribs are not interrupted on the venter. Also, the general shape of this ammonite resembles that of some varieties of *T. regleyi*. The whorl section is elliptical as in *T. regleyi* pictured in Plate XV, figure 1b. A similar form has been described by S. S. Buckman (1892) as *Polymorphites senescens* from the Jurensezone (Dumortieria beds) of Haresfield, England. This species also shows the ribs crossing the venter without interruption, but there are less ribs than in the Canadian form. Another, somewhat similar form, *Ammonites goslariensis* U. Schloenbach, from the Upper Lias of Doernten (Hanover, Germany) is pictured and described by Denckmann (1887)[1], but the ribs of this species are more arched and the inner whorls seem to be completely smooth, which is not true of the Canadian form.

Both Buckman's and Denckmann's forms are unique specimens.

Regarding the Canadian form, the writer is inclined to assume the possibility that it is a *Tmetoceras regleyi* that failed to reach the stage of interruption of the ribs on the venter, but until more material is collected it will not be possible to decide whether this assumption is correct or not. Until such a revision is possible, this form may be determined as '*Polymorphites*' cf. *senescens* Buckman.

[1] Denckmann, A.: Über die geognostischen Verhältnisse der Umgegend von Dörnten nördlich Goslar mit besonderer Berücksichtigung der Fauna des oberen Lias; Abh. geol. Spezialkarte Preussen, vol. VIII, 1887.

Other Fossils

In addition to the ammonites described here, some pelecypods, gastropods, and brachiopods *(Rhynchonella)* occur in the Whitesail Lake collections, but none seems to be of particular stratigraphic value. Among the pelecypods are: *Pleuromya* cf. *carlottensis* Whiteaves, *Pleuromya* sp., and *Parallelodon (Grammatodon)* sp. nov. A description of these forms must await further collections.

STRATIGRAPHIC REMARKS

Tmetoceras regleyi Dumortier has been hitherto unknown in Canada. In England it has been described by Buckman as *T. scissum*, and has been found in the lower part of the zone of *Harpoceras opalinum* = lower Bajocian[1] (lowermost Middle Jurassic), whereas Dumortier has reported this form from the Toarcian (uppermost Lower Jurassic or Lias) of the Rhone basin. As Dumortier's Toarcian also embraces the zone of *H. opalinum* it is probable that *T. regleyi* belongs to the same zone in both these regions. The nearly related *Tmetoceras scissum* Benecke was found in the zone with *H. murchisonae* at Garda Lake, Italy. This is a little younger zone than that with *H. opalinum.*

The presence of this Bajocian horizon in Canada has hitherto not been known. Its stratigraphic position is lower than that of the well-known and widespread Lower Yakoun fauna *(Stephanoceras* and *Chondroceras)* of British Columbia and its equivalents in the Fernie group of Alberta, which, according to McLearn, is Bajocian. It is also lower than the Sonninian fauna[3], which is locally found in the Fernie group of Alberta (Lake Minnewanka), whereas it is higher than the faunas with *Harpoceras, Fanninoceras,* and *Dactylioceras* (found at various places in British Columbia and Alberta), which, as stated by McLearn (1932[4], 1949[5]), belong to the Toarcian[6].

As both these Bajocian and Toarcian faunas are known from various regions in western, and in part northern, Canada, it is astonishing that the horizon with *Tmetoceras* has not been found before. Perhaps this lower part of the Middle Jurassic is only deposited locally within the Jurassic region of Canada, and perhaps the ammonite-bearing beds of the Whitesail Lake area are replaced by another facies in other parts of western Canada.

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[1] As there are possibilities for misunderstanding of the term "Bajocian" the writer wishes to point out that he is using it in the sense of the original definition given by d'Orbigny (cf. also S. W. Muller, 1941), according to which the Bajocian and, therefore, also the Middle Jurassic, begins at the bottom with the zone of *Leioceras opalinum*, whereas its upper boundary lies above the zone of *Parkinsonia parkinsoni*. This definition is among others also used by R. W. Imlay (1948)[2].

Other authors are using another subdivision, grouping the lower Bajocian and the uppermost Toarcian as a separate stage under the name "Aalenian", the upper part of which is placed in the Middle Jurassic, whereas its lower part forms the top of the Lias.

[2] Imlay, R. W.: Characteristic Marine Jurassic Fossils from the Western Interior of the United States; U.S. Geol. Surv., Prof. Pap. 214-B, 1948.

[3] McLearn, F. H.: Some Canadian Jurassic Faunas; Trans. Roy. Soc., Canada, 3rd ser., vol. XXI, sec. IV, 1927.

[4] McLearn, F. H.: Contributions to the Stratigraphy and Palæontology of Skidegate Inlet, Queen Charlotte Islands, B.C.; Trans. Roy. Soc., Canada, 3rd ser., vol. XXVI, sec. IV, 1932.

[5] McLearn, F. H.: Jurassic Formations of Maude Island and Alliford Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia; Geol. Surv., Canada, Bull. No. 12, 1949.

[6] To this horizon may also belong *Pleydellia* sp. indet., mentioned by Collet (1931)[7] as occurring in the Fernie group at Fiddle Creek and determined by him as Bajocien inférieur = Upper Toarcian according to the definition used here (cf. footnote 1 above). To the upper Toarcian also belongs *Porpoceras* cf. *subarmatum* Young and Bird from upper Red Deer River (cf. Hans Frebold, 1950)[8], formerly described as *Peltoceras occidentale* Whiteaves.

[7] Collet, Leon W.: Sur la présence du Lias supérieur et du Bajocien dans les couches de Fernie de Fiddle Creek; Compte rendu des Séances de la Soc. de Physique et d'Hist. Natur. de Genève, vol. 48, 1931.

[8] Frebold, Hans: Revision of "*Peltoceras*" *occidentale* Whiteaves from the Fernie Group of Upper Red Deer River, Alberta (this bulletin).

On Maude Island, Queen Charlotte Islands, British Columbia, McLearn (1949) notes that fine agglomerate and argillite, 600 to 800 feet thick, with rare belemnoids, lie between the ammonite-bearing beds of the Toarcian and Bajocian. Stratigraphically, this agglomerate and argillite section occurs where, among others, the horizon with *Tmetoceras* would also be expected.

PLATE I

(All figures natural size)

Types in collections of the Geological Survey of Canada

Figure 1. *Psiloceras canadense* sp. nov. la and lb, inner whorls; 1c, Id, and le, outer whorl of the same specimen; Ic and Id show the asymmetry of the suture line. From Tyaughton Creek, mile above Spruce Lake Creek, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Psiloceras* beds. Paratype, G.S.C. No. 11206A. (Page 3.)

Figure 2. *Psiloceras canadense* sp. nov. 2a, young specimen with straight primary ribs; 21) shows the secondary ribs on the venter. From right bank Spruce Lake Creek, 1,000 yards from the mouth, Tyaughton Lake map-area, British Columbia. L[T]pper Hettangian, *Psiloceras* beds. Paratype, G.S.C. No. 11206B. (Page 3.)

Figure 3. *Psiloceras canadense* sp. nov. 3a, lateral view; 3b, ventral region. From same locality and stratigraphic position as the specimen illustrated in Figure 2. Paratype, G.S.C. No. 11206C. (Page 3.)

Figure 4. *Psiloceras canadense* sp. nov. 4a and 41) show the ribs beginning to disappear on the outer part of the whorls and on the venter. From same locality and stratigraphic position as the specimen illustrated in Figure 1. Holotvpe, G.S.C. No. 11206. (Page 3.)

Figure 5. *Psiloceras canadense* sp. nov. 5a and 5b, in this stage of growth the primary ribs on the (lank and the very faint secondary ribs on the venter are still well developed; 5c shows cross-section of the same specimen. From same localitv and stratigraphic position as the specimen illustrated in Figure 1. Paratype, G.S.C. No. 11206D. (Page 3.)

Figure (>. *Psiloceras canadense* sp. nov. Younger specimen with well-developed primary ribs. From elevation (>,3(>0 feet on Last Creek, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Psiloceras* beds. Paratype. G.S.C. No. 11206E. (Page 3.)

PLATE II

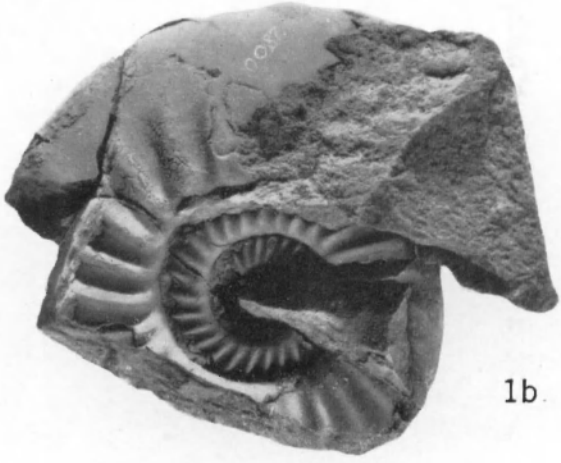
(All figures natural size)

Type in collections of the Geological Survey of Canada

Figure 1. *Psiloceras canadense* sp. nov. 1a and 1b show the disappearance of the ribs on the outer part of the flanks; 1c shows the broad ES, which occupies nearly the whole ventral region. From an elevation of 6,360 feet on Last Creek, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Psiloceras* beds. Paratype, G.S.C. No. 11206F. (Page 3.)

1a

1c



1b

PLATE III

(All figures natural size)

Types in collections of the Geological Survey of Canada

Figure 1. *Psiloceras canadense* sp. nov. (rubbercast). Large specimen. From Tyaughton Creek, ¾ mile above Spruce Lake Creek, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Psiloceras* beds. Paratype, G.S.C. No. 11206G. (Page 3.)

Figure 2. *Arietites* sp. indet. 2a shows the poorly preserved fragment in association with *Psiloceras canadense* sp. nov.; 2b shows the ventral region of the same specimen. From right bank Spruce Lake Creek, 1,000 yards from mouth, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Psiloceras* beds. (Page 4.)

Figure 3. *Schlotheimia* sp. indet. 3a shows the character of the ribs, 3b the ventral region of the same specimen. From same locality and stratigraphic position as Figure 2. (Page 5.)

PLATE III

PLATE IV

(All figures natural size)

Types in collections of the Geological Survey of Canada

Figure 1. *Schlotheimia (Scamnoceras)* cf. *acuticosta* S. S. Buckman. 1a, lateral view; 1b, venter; 1c, cross-section. From elevation of 6,425 feet on Last Creek, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Schlotheimia* beds. (Page 6.)

Figure 2. *Schlotheimia*(?) sp. indet. 2a, lateral view; 2b, the almost smooth venter; 2c, cross-section. From elevation of 6,160 feet on Last Creek, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Schlotheimia* beds (?). (Page 7.)

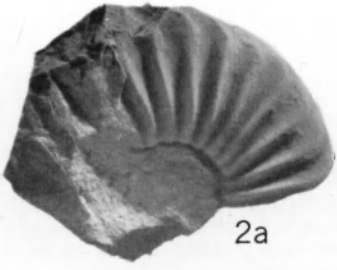
Figures 3, 4. *Schlotheimia*(?) sp. indet. 3a and 4a, lateral views; 3b and 4b, the almost smooth ventral region. From elevation of 6,220 feet on Last Creek, Tyaughton Lake map-area, British Columbia. Upper Hettangian, *Schlotheimia* beds (?). (Page 7.)

1b

1a

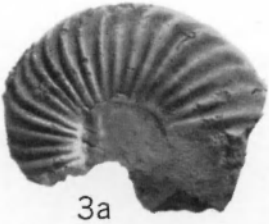
1c

2b



2a

2c



3a

4a

PLATE V

(All figures natural size)

Types in collections of the Geological Survey of Canada

Figures 1 to 4. *Vermiceras scylla* Reynès. 1, 2, 3, 4a, lateral views; 4b and 4c show the weak keel. One-half mile east of Gate Creek and just 1 mile south of Spruce Lake, Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 7.)

Figures 5, 6. *Vermiceras scylla* Reynès. 5a, 6a, lateral views of fragments; 5b and 6b show the keel; no furrows present. Same locality as figures 1 to 4. Lower Sinemurian, *Arietites* beds. (Page 7.)

Figure 7. *Vermiceras scylla* Reynès. 7a, fragment of a larger specimen; 7b shows part of a cross-section of 7a; no furrows on the venter. Same locality as figures 1 to 4. Lower Sinemurian, *Arietites* beds. (Page 7.)

PLATE VI

(All figures natural size)

Types in collections of the Geological Survey of Canada

Figures 1, 2. *Vermiceras scylla* Reynès. 1, rubbercast of a larger specimen, lateral view; 2, fragment of a larger specimen. One-half mile east of Gate Creek and just over 1 mile south of Spruce Lake, Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 7.)

Figure 3. *Coroniceras* cf. *bisulcatum* Brug., lateral view of a fragment from 2½ miles east and about ½ mile north of northwest corner of Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 9.)

Figure 4. *Porpoceras* cf. *subarmatum* Young and Bird. Type of *Peltoceras occidentale* Whiteaves. 4a, lateral view; 4b, ventral view. Red Deer River (Alberta), in Rocky Mountain Park. Upper Lias. (Page 15.)

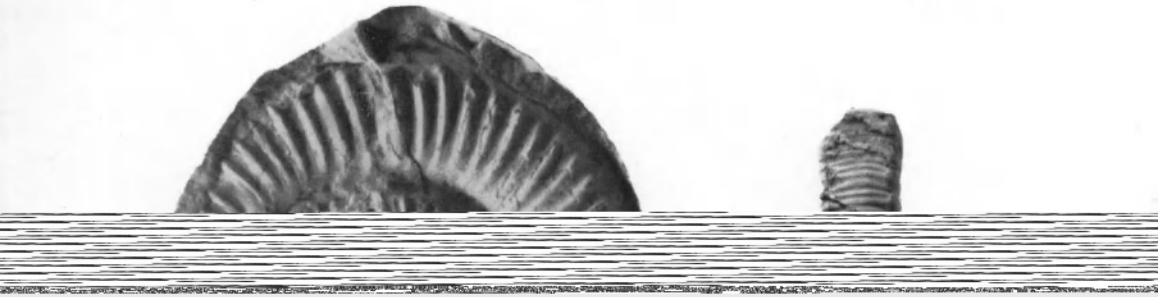


PLATE VII

(All figures natural size)

Type in collections of the Geological Survey of Canada

Figure 1. *Vermiceras latisulcatum* Quenstedt. Same specimen as in Plate VIII. 1a, lateral view, with the broad ES divided by a deep incision; 1b, ventral view; 1a shows the asymmetry of the suture line. Last Creek, elevation 5,900 feet, Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 8.)

PLATE VII

1a 1b

PLATE VIII

(All figures natural size)

Type in collections of the Geological Survey of Canada

Figure 1. *Vermiceras latisulcatum* Quenstedt. The same specimen as figured in Plate VII. Figures 1a and 1b show the asymmetry of the suture line, with E lying partly on the flank; no incision of ES on this flank. (Page 8.)

PLATE VIII

1b

1a

PLATE IX

(One-half natural size)

Type in collections of the Geological Survey of Canada

Figure 1. *Coroniceras bisulcatum* Bruguière. Lateral view of a large specimen (the same specimen as in Plates X, XI). Last Creek tributary, elevation 6,680 feet, Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 9.)

PLATE IX

½ of natural size

1

PLATE X

(Natural size)

Type in collections of the Geological Survey of Canada

Figure 1. *Coroniceras bisulcatum* Bruguière. The same specimen as in Plate IX, figure 1, but without the last whorl. Lateral view with parts of the suture line. (Page 9.)

PLATE X

1

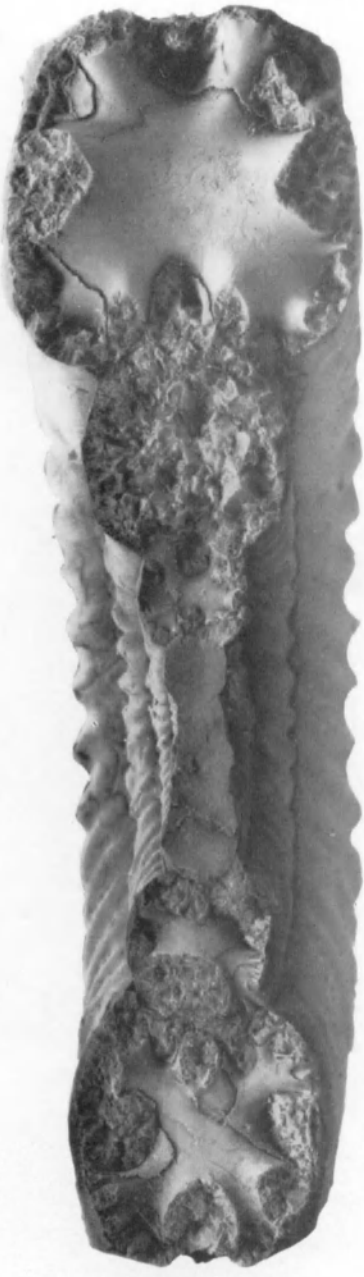
PLATE XI

(All figures natural size)

Type in collections of the Geological Survey of Canada

Figure 1. *Coronicceras bisulcatum* Bruguière. The same specimen as in Plate IX, figure 1. and Plate X, figure 1 (without the last whorl); 1a, ventral region; 1b, cross-section. (Page 9.)

1a



1b

PLATE XII

(Natural size)

Type in collections of the Geological Survey of Canada

Figure 1. *Coroniceras bisulcatum* Bruguière. Lateral view of a smaller specimen. Last Creek tributary, elevation 6,680 feet, Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 9.)

PLATE XII

1

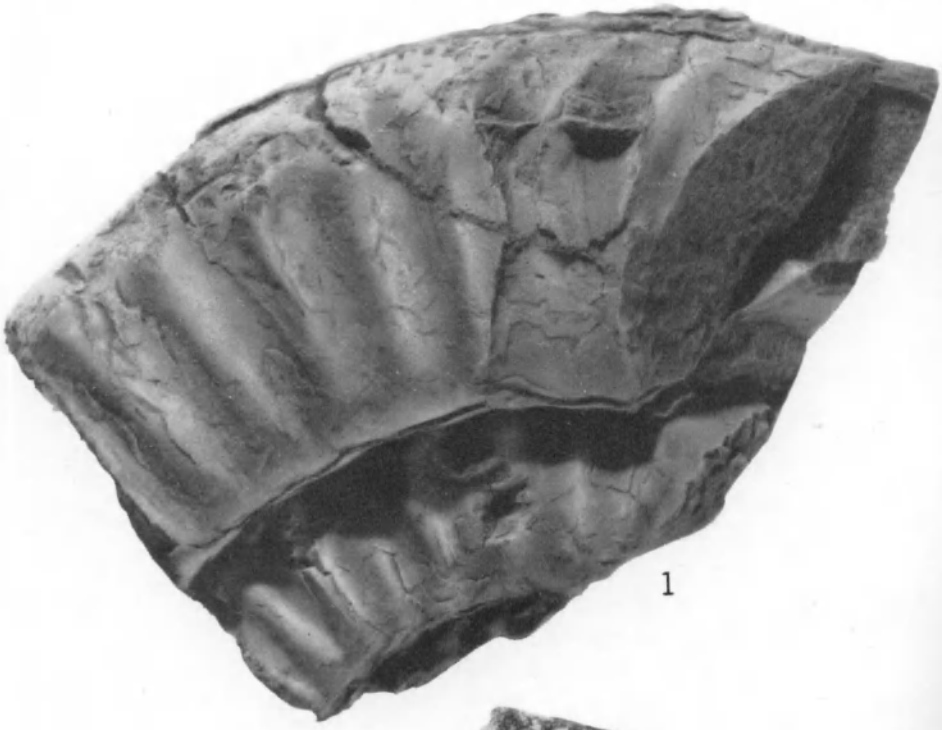
PLATE XIII

(All figures natural size)

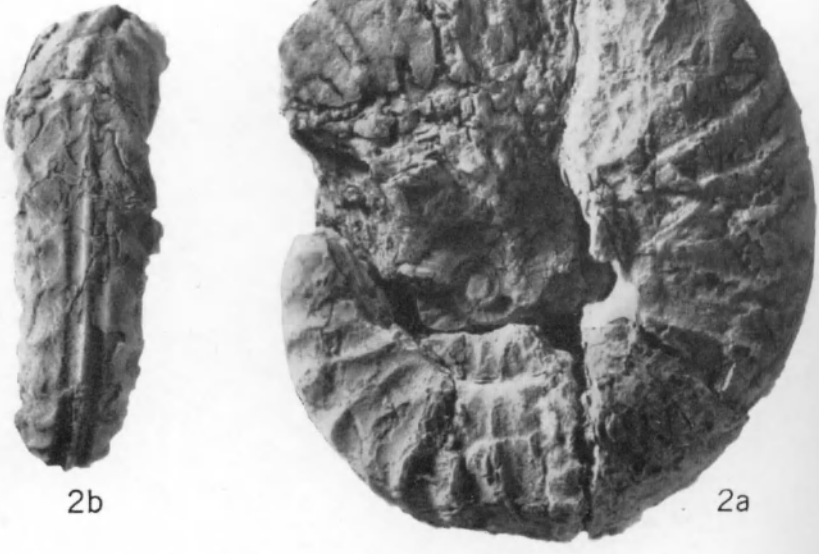
Types in collections of the Geological Survey of Canada

Figure 1. *Coroniceras bisulcatum* Bruguière. Lateral view of a fragment. Last Creek tributary, elevation 6,680 feet, Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 9.)

Figure 2. *Asteroceras* cf. *stellare* Sowerby. 2a, lateral view; 2b, ventral region. Two miles above Spruce Lake Creek, Tyaughton Lake map-area. Sinemurian. (Page 11.)



1



2b

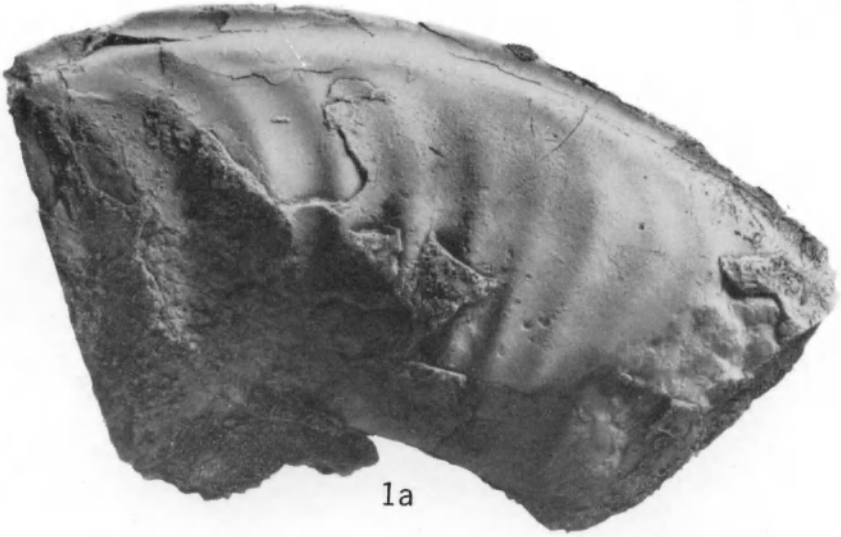
2a

PLATE XIV

(All figures natural size)

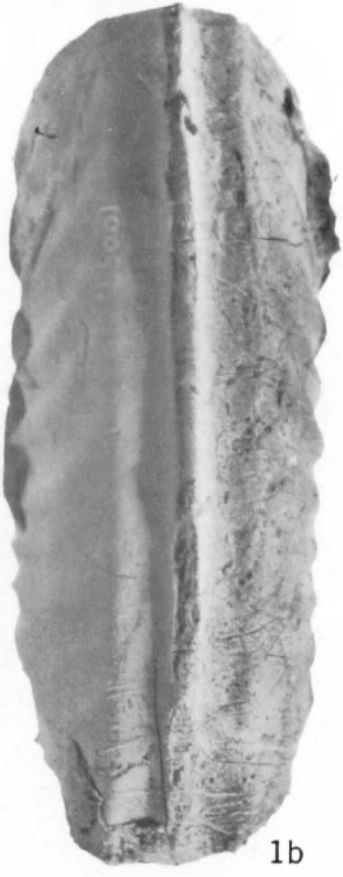
Types in collections of the Geological Survey of Canada

Figure 1. *Agassiceras* cf. *scipion anum* d'Orbigny. 1a, lateral view; 1b, ventral region; 1c, cross-section. Last Creek tributary, elevation 6,680 feet, Tyaughton Lake map-area. Lower Sinemurian, *Arietites* beds. (Page 10.)



1a

1c



1b

PLATE XV

(All figures, except 4b, natural size)

Types in collections of the Geological Survey of Canada

Figure 1. *Tmetoceras regleyi* Dumortier. Figure 1a, rubbercast of the inner whorls: 1b, cross-section of the last whorl. Locality T 115 F, northwest ridge of Troitsa Peak, ½ mile south of Loc. T 114 F, Whitesail Lake area. Lowermost Middle Jurassic (Lower Bajocian). (Page 18.)

Figure 2. *Tmetoceras regleyi* Dumortier. Figure 2a, imprint of the inner whorls and fragment of the last preserved whorl; 2c, rubbercast of the imprint of the inner whorls; 2b, part of the ventral region. Loc. T 114 F, northwest ridge of Troitsa Peak, 1 mile south of Loc. T 112 F, Whitesail Lake area. Lowermost Middle Jurassic (Lower Bajocian). (Page 18.)

Figure 3. *Tmetoceras regleyi* Dumortier. Rubbercast of an imprint. Same locality and strati graphic position as Figure 2. (Page 18.)

Figure 4. *Tmetoceras regleyi* Dumortier. Figures 4a, 4b, rubbercast of a small specimen found in the same piece of rock as "*Polymorphites*" cf. *senescens* Buckman (cf. fig. 5b). Figure 4b = figure 4c (enlarged) to show the interruption of the ribs on the venter. Same locality and stratigraphic position as Figure 1. (Page 18.)

Figure 5. "*Polymorphites*" cf. *senescens* Buckman. Figure 5a, lateral view. Only a part of the outer whorl preserved as cast, the inner whorls (*See* Figure 5b) as imprint. Figure 5b, rubbercast of the inner whorls of the same specimen (together with the small *Tm. regleyi* Dumortier, cf. Figure 4a). Figure 5c, venter of an inner whorl (rubbercast). Figure 5d, venter of the last whorl, both of the same specimen. In both 5c and 5d the ribs are crossing the venter without interruption. Same locality and stratigraphic position as Figure 1. (Page 19.)

1a

1b

2a

2c

2b

3

4a

4b

4c

5c

5d

5a

5b

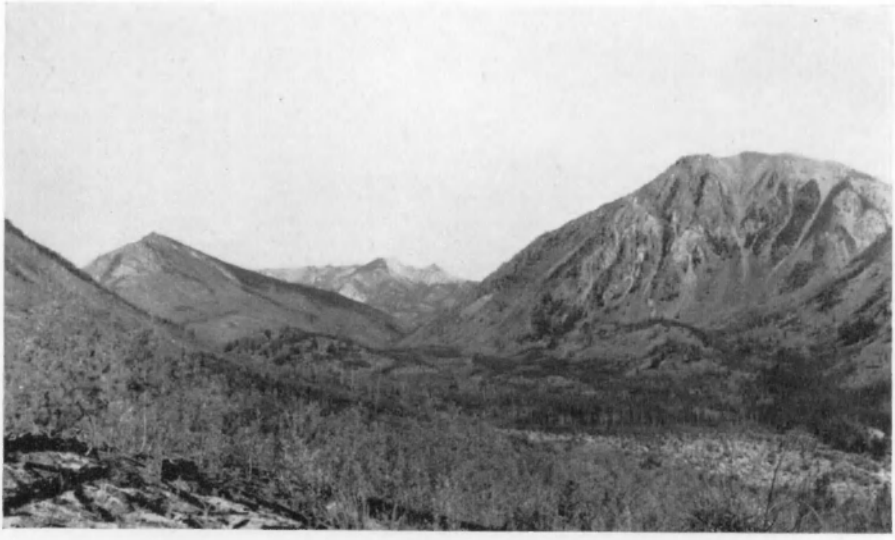
PLATE XVI

A. View looking westerly from near the head of Bon Creek across an area of exposed Mesozoic sedimentary formations to granitic peaks of the Coast Mountains in the distance.

B. View southerly to southwesterly from the Taylor Creek-Bon Creek divide across area of mainly Jurassic and Triassic sedimentary rocks to high, rugged, granitic peaks of the Coast mountains.

PLATE XVII

A. View northerly from Leckie Creek-Gun Creek divide across an area of mainly late Mesozoic volcanic and sedimentary rocks to Sheba Mountain, which has an elevation of 8,743 feet.



B. View northwesterly up the valley of Gun Creek from about 2 miles below the mouth of Eldorado Creek. The hills on either side are underlain mainly by Mesozoic sedimentary formations.

PLATE XVIII

A. View northerly from near summit of Sheba Mountain across Tyaughton Creek Valley to slopes underlain by Mesozoic sedimentary formations capped by flat-lying Tertiary lavas.

B. View northerly across Tyaughton Creek Valley from pass at head of northwest fork of Eldorado Creek. Both near and distant slopes underlain mainly by early Mesozoic sedimentary formations, capped on some of the higher peaks by Tertiary lavas.

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